



## Original communication

## Review of forensically important entomological specimens collected from human cadavers in Malaysia (2005–2010)



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## ABSTRACT

Forensic entomological specimens collected from human decedents during crime scene investigations in Malaysia in the past 6 years (2005–2010) are reviewed. A total of 80 cases were recorded and 93 specimens were collected. From these specimens, 10 species of cyclorrhagic flies were identified, consisting of *Chrysomya rufifacies* (Macquart) –38 specimens (40.86%), *Chrysomya megacephala* (Fabricius) –36 specimens (38.70%), *Chrysomya villeneuvei* (Patton) –2 specimens (2.15%), *Chrysomya nigripes* (Aubertin) –2 specimens (2.15%), *Chrysomya pinguis* (Walker) –1 specimen (1.08%), *Hermetia illucens* (Linnaeus) –1 specimen (1.08%), *Hemipyrellia liguriens* (Wiedemann) –5 specimens (5.37%), *Synthesiomyia nudiseta* (Wulp) –1 specimen (1.08%), *Megaselia scalaris* (Loew) –1 specimen (1.08%) and *Sarcophaga ruficornis* (Fabricius) –4 specimens (4.30%). In two specimens (2.15%), the maggots were not identifiable. *Ch. megacephala* and *Ch. rufifacies* were the commonest species found in human decedents from three different ecological habitats. *S. nudiseta* is an uncommon species found only on human cadavers from indoors. A total of 75 cases (93.75%) had a single fly infestation and 5 cases (6.25%) had double fly infestation. In conclusion, although large numbers of fly species were found on human decedents, the predominant species are still those of *Chrysomya*.

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## 1. Introduction

Forensic entomology is a discipline that can be used as a tool in crime scene investigations. Insects are usually the first visitors to a dead body.<sup>1</sup> The insects that have been most studied in relation to their forensic value in investigations of suspicious deaths are the blowflies (bluebottle and green bottle flies), in particular their maggots (larvae) because they are the insects that are most commonly associated with corpses, they colonize the body most rapidly after death and in greater numbers than most other insects groups. They usually provide the most accurate information regarding time of death and they are also the most obvious organisms found on corpse.<sup>2</sup>

Forensic entomology is used mainly to estimate the time of death or postmortem interval (PMI), based on the developmental rates

and the successional ecology of specific insects that feed on corpses.<sup>3</sup> In Malaysia, Reid<sup>4</sup> summarized the first forensic entomology case from Penang, who found *Chrysomya megacephala* (Fabricius) larvae in a dead woman. Reid<sup>4</sup> also published notes on flies of forensic importance. Lee et al.,<sup>5</sup> Lee<sup>6</sup> and Lee et al.<sup>7</sup> reviewed and updated forensically important entomological specimens in the period of 1972–2002. Hamid et al.<sup>8</sup> also reviewed the their collection of forensically important entomological specimens.

The main objective of this study is to examine forensically important entomological specimens obtained from 80 human cadavers during crime scene investigation in Malaysia for the six years period of 2005–2010.

## 2. Methods

## 2.1. Maggot specimens

A total of 93 entomological specimens collected from 80 human cadavers from 2005 to 2010 during crime scene investigations in

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**Table 1**

Number of forensic cases examined from 2005 to 2010.

Year	Number of forensic cases
2005	1
2006	7
2007	22
2008	2
2009	43
2010	5
Total	80

Malaysia were submitted to the Medical Entomology Unit, Institute for Medical Research, Kuala Lumpur for analysis. A representative sample comprising both big and small size maggots was collected randomly from each cadaver. Specimens were collected in glass universal bottles and preserved in 70% ethanol. Each bottle was accompanied with a police report and short notes of the case, name of decedents (if known), date and time of collection and name of collector. Samples collected were immediately registered in a log book for record purposes. Various stages of flies from the decomposing bodies were collected and processed immediately by established standard procedures, as described previously by Lee et al.<sup>5</sup>

## 2.2. Processing of preserved maggot samples for identification

Maggots were first rinsed in distilled water several times after removing from 70% ethanol. They were then transferred into a petri dish using forceps. Posterior segments of the maggots were cut transversely with a sharp surgical blade. The maggots and the posterior segments were then soaked in 10% potassium hydroxide (KOH) overnight for cuticle softening purposes.

On the next day, the internal organs of maggots were removed carefully using applicator sticks to avoid damaging those parts of taxonomic importance, such as anterior and posterior spiracles, spines, and the cephalopharyngeal sclerites. The maggots were then soaked in acetic acid for 10 min to neutralize the KOH. The maggots were then dehydrated by soaking in ascending series of ethanol: 30%, 50%, 70% and 90%, at 30 min for each concentration. The maggots were then transferred into clove oil for 30 min, which served as a clearing agent. They were then soaked in xylene for 30 min before being mounted onto glass slides. The slides were labelled and dried in an oven at 70 °C for 24 h. Species identification was done as soon as the slide dried thoroughly. The maggots were identified according to Byrd & Castner<sup>9</sup> and Greenberg & Kunich<sup>10</sup> and keys prepared by Institute for Medical Research (IMR), Medical Illustration X and XII.

**Table 2**

Total number of specimens examined.

Fly species	Number of specimens
<i>Chrysomya rufifacies</i>	38
<i>Chrysomya megacephala</i>	36
<i>Chrysomya pinguis</i>	1
<i>Chrysomya villeneuvi</i>	2
<i>Chrysomya nigripes</i>	2
<i>Sarcophaga ruficornis</i>	4
<i>Hemipyrellia liguriens</i>	5
<i>Hermetia illucens</i>	1
<i>Synthesiomysia nudiseta</i>	1
<i>Megaselia scalaris</i>	1
Not identifiable	2
Total	93

**Table 3**

Infestation of fly in human cadavers.

Fly infestation	Number of forensic cases
Single fly	74
Double fly	6
Total	80

## 3. Results

A total of 80 human cadavers were examined for entomological specimens from the year 2005–2010 (Table 1). From these cadavers, 93 maggot specimens were collected (Table 2) which comprised a total of 10 species consisting of 5 species of *Chrysomya* (50.00%), 1 species each of *Sarcophaga ruficornis* (10.00%), *Hemipyrellia liguriens* (10.00%), *Hermetia illucens* (10.00%), *Megaselia scalaris* (10.00%) and *Synthesiomysia nudiseta* (10.00%). The majority of infestation is single fly species accounting for 92.5% (Table 3). Two species, namely *Chrysomya rufifacies* (Fig. 1) and *Ch. megacephala* (Fig. 2) were commonly found either as single infestation or double infestation in human cadavers.

The ecological habitats where the cadavers were found were classified into rural, residential and aquatic habitat. *Chrysomya* larvae were predominantly found in human cadavers in all the three habitats namely rural, residential and aquatic areas (Table 4). Overall, *Chrysomya* larvae were the most commonly found immatures in all the three habitats (84.9%).

## 4. Discussion

Entomological evidence collected from human cadavers during crime scene investigation has a long history of being utilised for PMI determination. This report, though only reviewing the specimens received in the period of 2005–2010, provided some insights into the nature of specimens collected from human cadavers during crime scene investigation. A total of 10 cyclorrhaphic fly species were recorded from this study, indicating that a large number of flies were attracted to human cadavers under tropical conditions. In Malaysia, the predominant fly species were those of *Chrysomya* species in which a total of 5 species were recorded. *Ch. rufifacies* and *Ch. megacephala* were the commonest fly recovered from human cadavers during crime scene investigation in Malaysia. Their ability to survive and compete successfully in the human cadaver environment accounted for the predominance of *Chrysomya* species.

**Fig. 1.** Maggot of *Ch. megacephala*.



Fig. 2. Maggot of *Ch. rufifacies*.

Table 4

Ecological sites where human cadavers were found.

Ecological Site	Number of forensic cases
Rural	40
Residential	31
Aquatic	9
Total	80

In Malaysia, Lee<sup>5</sup> also identified maggots of *Ch. megacephala* and *Ch. rufifacies* as the predominant maggots in 63% of human cadavers. Later, Lee<sup>6</sup> reviewed the recovery of forensically important entomological specimens from human cadavers in Malaysia and reported maggots of the blowfly *Chrysomya* especially *Ch. rufifacies* and *Ch. megacephala* were found in 77 cases (76.2%), while larvae of several other flies of the genera *Sarcophaga*, *Calliphora*, *Lucilia*, *Megaselia* and *Hermetia* were also recovered. In a more recent review, Lee et al.<sup>7</sup> stated that although large number of fly species was found on human cadavers, the predominant species was still those of *Ch. megacephala* and *Ch. rufifacies*.

According to Lee et al.,<sup>7</sup> *S. nudisetia* is a rare species in Malaysia and found only on indoor cadavers. The present study showed the same finding as the larvae of this fly species were found in only one case whereby the cadaver was found inside a house. Omar et al.<sup>11</sup> reported that larvae of *H. illucens* can only be found during the early stage of the decomposition stage. However, in the present study, larvae of *H. illucens* were found on a highly decomposed body. In a neighbouring country, Sukontason et al.<sup>12</sup> reviewed forensic entomology cases in Thailand from 2000 to 2006 and identified *Ch. megacephala* and *Ch. rufifacies* as the most common species found in the ecologically varied death scene habitats associated with both urban and forested areas.

The collection contained two maggot specimens that could not be identified. This was attributed to poor killing and preservation techniques resulting in distorted morphological features. It is

recommended that at the crime scene the forensic officer should use only warm water (about 60–70 °C) to kill the maggots and preserve the killed maggots in 70% ethanol. If the maggots are killed in boiling water, the maggots will be charred and blackened, thus masking important taxonomic features and rendering identification difficult or impossible. Killed maggots preserved in solutions other than 70% ethanol would damage them, making subsequent mounting difficult, hence affecting important taxonomic profiles.<sup>13</sup>

## 5. Conclusion

Based on the previous review of forensic cases for the past 30 years period (1972–2002) and the present study (2005–2010), it revealed that *Ch. megacephala* and *Ch. rufifacies* remains the predominant blow fly species attracted to and infesting human cadavers in Malaysia. Hence detailed biological studies on these two species are essential for the application of forensic entomology in crime scene investigation particularly in Malaysia.

## Ethical approval

Not required.

## Funding

None.

## Conflict of interest

There is no conflict of interest with anybody nor organisation.

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